Bureau of Land Management

Reno, Nevada

Annual Emissions Inventory for BLM Vegetation Treatment Methods

Final Report

April 2005

Bureau of Land Management Contract No. NAD010156
ENSR Document Number 09090-020-610

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

The U.S. Department of Interior (USDI) Bureau of Land Management (BLM) is proposing a program to treat vegetation on up to 6 million acres of public lands annually in 17 western states in the continental U.S. and Alaska. The primary objectives of the proposed program include fuels management, weed control, and fish and wildlife habitat restoration. Vegetation would be managed using five primary vegetation treatment methods: prescribed fire, mechanical, manual, biological, and chemical.

The purpose of this report is to present total estimated air pollutant emissions for each proposed herbicide treatment alternative and for other treatment methods by state. The comparison of impacts presents annual emissions for the proposed alternatives and treatments by state for the following compounds: carbon monoxide (CO), carbon dioxide (CO_2), total suspended particulate matter (TSP), particulate matter under 10 microns in size (PM_{10}), particulate matter under 2.5 microns in size ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), and volatile organic compounds (VOCs).

Sections 2 and 3 of this report focus on the method used in the development of an emissions inventory for each alternative action (herbicide and non-herbicide), based on example scenarios provided by the BLM (USDI BLM 2003) for each of the five vegetation treatment methods and herbicide treatment alternatives. Section 2 describes the types of activities and the emission factors for each treatment method. Section 3 describes how the emission factors were applied to determine annual pollutant emissions for each alternative by state. Section 4 of this document presents the total estimated air pollutant emissions for each proposed alternative and treatment method by state. Spreadsheets containing the actual emissions calculations are attached in the appendices.

2.0 EMISSION FACTORS FOR VEGETATION TREATMENTS

The BLM manages vegetation using five primary vegetation treatment methods: prescribed fire, mechanical, manual, biological, and chemical. This section describes the activities involved in each treatment method and their emission factors. Section 3 further describes these activities and their assumptions, as well as how the emission factors were applied to determine annual pollutant emissions for each state and alternative. Applicable emission factors to be used have been numbered in the text for ease of reference.

2.1 Prescribed Fire

Prescribed fire includes both the natural and intentional application of fire to wildland fuels under specified conditions of fuels, weather, and other variables. The intent is for the fire to burn under a predetermined set of conditions to achieve site-specific resource management objectives. Typical daily activities include the following:

- Igniting the fire after 9 a.m. and extinguishing it by 6 p.m. on the same day, burning a predetermined acreage of fuel per day.
- Vehicle transportation of all personnel, using command vehicles, fire engines, lighter's vehicles, helicopter service trucks, terra torch trucks (used for ignition), and terra torch service trucks.
- Pre-treatment and post-treatment activities using bulldozers with blades (delivered via semi truck).

Emission factors for air pollutants produced from prescribed fire are based on the mass of material burned in kilograms (kg) and depend on the type of fuel burned, combustion efficiency, and combustion type (i.e., flaming or smoldering combustion). The BLM has provided the operations assumptions and the emission factors (Battye 2002) to use for each state:

Carbon monoxide (CO grams/kilogram [g/kg])
75 g/kg (Table 39, CO, flaming [Grass])
60 g/kg (Table 38, CO, broadcast-burned brush, chaparral, flaming)
99 g/kg (Table 38, CO, broadcast-burned brush, chaparral, smoldering)
72 g/kg (Table 38, CO, broadcast-burned slash, Douglas-fir/hemlock, flaming)
232 g/kg (Table 38, CO, broadcast-burned slash, Douglas-fir/hemlock, smoldering)
46 g/kg (Table 38, CO, broadcast-burned slash, hardwoods, flaming)
183 g/kg (Table 38, CO, broadcast-burned slash, hardwoods, smoldering)
41 g/kg (Table 38, CO, broadcast-burned slash, juniper, flaming)
125 g/kg (Table 38, CO, broadcast-burned slash, juniper, smoldering)
45 g/kg (Table 38, CO, broadcast-burned slash, ponderosa/lodgepole pine, flaming)
143 g/kg (Table 38, CO, broadcast-burned slash, ponderosa/lodgepole pine, smoldering)
78 g/kg (Table 38, CO, broadcast-burned brush, sagebrush, flaming)
106 g/kg (Table 38, CO, broadcast-burned brush, sagebrush, flaming)

Carbon dioxide (CO_2)
1,650 g/kg (Table 39, CO_2, flaming)
1,393 g/kg (Table 39, CO_2, smoldering)

Lead (Pb)
0.0017 x 9$PM_{2.5}$0 g/kg (Table 39, Pb, Empirical relationships)

Oxides of nitrogen (NO_x)
3.5 g/kg (Table 39, NO_x, grasses, overall)
3.1 g/kg (Table 39, NO_x, forest fuels, flaming)
1.1 g/kg (Table 39, NO_x, forest fuels, smoldering)
10.0 g/kg (Table 39, NO_x, scrub and sage, flaming [assumed])
3.0 g/kg (Table 39, NO_x, scrub and sage, smoldering)

Fine Particulate Matter ($PM_{2.5}$)
7.3 g/kg (Table 39, $PM_{2.5}$, flaming grass)
13.5 g/kg (Table 38, $PM_{2.5}$, wildfires-average, fire average)
6.8 g/kg (Table 38, $PM_{2.5}$, broadcast-burned brush, chaparral, flaming)
10.8 g/kg (Table 38, $PM_{2.5}$, broadcast-burned brush, chaparral, smoldering)
7.5 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, Douglas-fir/hemlock, flaming)
13.1 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, Douglas-fir/hemlock, smoldering)
6.1 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, hardwoods, flaming)
11.7 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, hardwoods, smoldering)
7.0 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, juniper, flaming)
11.9 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, juniper, smoldering)
5.0 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, ponderosa/lodgepole pine, flaming)
17.1 g/kg (Table 38, $PM_{2.5}$, broadcast-burned slash, ponderosa/lodgepole pine, smoldering)
14.6 g/kg (Table 38, $PM_{2.5}$, broadcast-burned brush, sagebrush, flaming)
13.2 g/kg (Table 38, $PM_{2.5}$, broadcast-burned brush, sagebrush, smoldering)

Inhalable Particulate Matter (PM_{10}) and Total Suspended Particulate Matter (TSP) [assumed]
8.6 g/kg (Table 39, PM_{10}, flaming grass)
15.0 g/kg (Table 38, PM_{10}, wildfires-average, fire average)
8.3 g/kg (Table 38, PM_{10}, broadcast-burned brush, chaparral, flaming)
12.4 g/kg (Table 38, PM_{10}, broadcast-burned brush, chaparral, smoldering)
8.3 g/kg (Table 38, PM_{10}, broadcast-burned slash, Douglas-fir/hemlock, flaming)
13.8 g/kg (Table 38, PM_{10}, broadcast-burned slash, Douglas-fir/hemlock, smoldering)
7.0 g/kg (Table 38, PM_{10}, broadcast-burned slash, hardwoods, flaming)
13.0 g/kg (Table 38, PM_{10}, broadcast-burned slash, hardwoods, smoldering)
7.7 g/kg (Table 38, PM_{10}, broadcast-burned slash, juniper, flaming)
12.9 g/kg (Table 38, PM_{10}, broadcast-burned slash, ponderosa/lodgepole pine, flaming)
18.4 g/kg (Table 38, PM_{10}, broadcast-burned slash, ponderosa/lodgepole pine, smoldering)
15.9 g/kg (Table 38, PM_{10}, broadcast-burned slash, sagebrush, flaming)
14.8 g/kg (Table 38, PM_{10}, broadcast-burned slash, sagebrush, smoldering)

Sulfur dioxide (SO_2)
0.83 g/kg (Table 39, SO_2, overall)

Volatile Organic Compounds (VOCs)
4.8 g/kg (Table 39, VOCs, flaming)
8.4 g/kg (Table 39, VOCs, smoldering)

Basic, non-tampered exhaust emission factors (in grams per vehicle mile traveled; gm/VMT) for vehicles used for transportation are dependent on vehicle mileage, model year, type of fuel, weight (light duty or heavy duty), and altitude (for some vehicle types). Emission factors for the fugitive dust resulting from road use by these vehicles are dependent on whether the roads are paved or unpaved, trip mileage, and soil properties (for unpaved roads). Vehicle and road assumptions provided by the BLM were used to determine the appropriate emission factors from the following sections of the U.S. Environmental Protection Agency's (USEPA) Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition (USEPA 1995a, 1995b, and 2003):

(1) Tables 3.1A.1 and 3.1B.1 (USEPA 1995b), for exhaust from Command Vehicles, lighter's vehicles, Terra Torch service trucks (assuming 1998 model-year, light-duty, gasoline powered trucks or vans with 50,000 miles previous use):

High/low altitude use
CO – 10.489 gm/VMT
NO_x – 0.837 gm/VMT
VOCs – 0.628 gm/VMT

(2) Table 7.1.1 (USEPA 1995b), for exhaust from low altitude fire engines, helicopter service trucks, Terra Torch trucks, and semi trucks (assuming 1998 model-year, heavy-duty, diesel powered trucks with 50,000 miles previous use):

Low altitude use
CO – 9.930 gm/VMT
NO_x – 6.490 gm/VMT
VOCs – 2.100 gm/VMT

(3) Table 7.1.2 (USEPA 1995b), for exhaust from high altitude fire engines, helicopter service trucks, Terra Torch trucks, and semi trucks (assuming 1998 model-year, heavy-duty, diesel powered trucks with 50,000 miles previous use):

High altitude use
CO – 17.070 gm/VMT
NO_x – 6.490 gm/VMT
VOCs – 4.820 gm/VMT

(4) Table 13.2.2 (USEPA 2003), for fugitive dust (TSP, PM_{10}, and $PM_{2.5}$) from vehicles traveling on unpaved roads.

Size-specific emissions (lb/VMT) = $[k \times (s/12) \times (S/30)^a] / [(M/0.5)^b] - C$

Where: k = 6.0 for TSP, 1.8 for PM_{10}, or 0.27 for $PM_{2.5}$
a = 0.3 for TSP, 0.5 for PM_{10}, or 0.5 for $PM_{2.5}$
b = 0.3 for TSP, 0.2 for PM_{10}, or 0.2 for $PM_{2.5}$
C = 0.00047 for TSP, 0.00047 for PM_{10}, or 0.00036 for $PM_{2.5}$
s = silt content (percent)
S = mean vehicle speed (mph)
M = moisture content (percent)

Emission factors for exhaust from bulldozers with blades are not the same as those for a heavy-duty truck. Because the pre-treatment and post-treatment activities take place within a specified area, it is more appropriate to assume that they are stationary, rather than mobile sources. Emission factors for diesel industrial engines were therefore used. The following sections of USEPA's AP-42 were used to determine emission factors for the above pre-treatment and post-treatment activities:

(5) Table 3.3-1 (USEPA 1995a), for exhaust from bulldozers with blades (assuming stationary heavy-duty, diesel powered equipment):

CO – 3.03 gm/hp-hr (grams per horsepower-hour)
CO_2 – 522 gm/hp-hr
NO_x – 14.06 gm/hp-hr
$TSP/PM_{10}/PM_{2.5}$ – 0.998 gm/hp-hr

SO_2 – 0.930 gm/hp-hr
VOCs – 1.14 gm/hp-hr

(6) Table 11.9-1 (USEPA 1995a), for fugitive dust (TSP, PM_{10}, and $PM_{2.5}$) due to active bulldozing of overburden (surface soil):

Size-specific emissions (lb/hr) = $[k_1 \times k_2 \times (s)^a] / [(M)^b]$

Where: k_1 = 1.0 for TSP, 0.75 for PM_{10}, or 0.105 for $PM_{2.5}$
k_2 = 5.7 for TSP, 1.0 for PM_{10}, or 5.7 for $PM_{2.5}$
a = 1.2 for TSP, 1.5 for PM_{10}, or 1.2 for $PM_{2.5}$
b = 1.3 for TSP, 1.4 for PM_{10}, or 1.3 for $PM_{2.5}$
s = silt content (percent)
M = moisture content (percent)

Emission factors for fugitive dust resulting from wind erosion of particulate matter from the vegetation pre-treatment area (assumed to occur in Nevada, New Mexico, and Utah only) are dependent on both soil properties and meteorology (e.g., precipitation, temperature, wind speed). Soil assumptions provided by the BLM, as well as readily available meteorological data (both specified in Section 2.2 below), were used to determine emission factors from the following source:

(7) Section 13.2.5 from USEPA (1995a) was used to estimate each state's annual average erosion potential (in gm/m^2) from undisturbed land, as well as scaling factors for TSP, PM_{10}, and $PM_{2.5}$.

Size-specific emissions (gm/m^2-hr) = $k \times [58(u^* - u_t^*)^2 + 25(u^* - u_t^*)]$

Where: k = 1.0 for TSP, 0.5 for PM_{10}, or 0.2 for $PM_{2.5}$;
u^* = Hourly surface friction velocity (meters per second (m/s), obtained from PCRAMMET based upon observed wind speed, stability, and boundary layer characteristics); and
u_t^* = Assumed statewide average surface threshold friction velocities (m/s, specified in Section 2.2).

Hourly size-specific emissions (grams per square-meter per hour (gm/m^2-hr)) = 0 when:

$u^* < u_t^*$;
hourly precipitation $\geq$ 0.01 inch;
hourly ambient temperature $\leq$ 28 degrees Fahrenheit; or
hourly snow cover $\geq$ 1.0 inch.

2.2 Mechanical Treatment

Mechanical treatment methods involve the use of vehicles such as tractors and bulldozers or other specially designed vehicles with attached implements to remove vegetation. Typical daily activities include the following (USDI BLM 2003):

- Operation of tractors (delivered via trailer) to mow grasses, forbs, and small shrubs and drilling of new seed for two consecutive 8-hour days, beginning after 9 a.m. and ending by 5 p.m. each day, treating a total of 100 acres.

- Operation of bulldozers, articulating loaders, and tractors (delivered via semi truck) to blade and pile shrubs and small trees for 17 consecutive days, beginning after 9 a.m. and ending by 5 p.m. each day, treating a total of 100 acres.

- Vehicle transportation of all personnel to site using pick-up trucks.

Bulldozers, articulating loaders, and tractors were considered stationary sources because mowing and blading/piling activities occur in a specified area. Therefore, emission factors for industrial diesel engines from source **(5)** were used.

Emission factors for fugitive dust during blading/piling were determined using soil properties provided by the BLM and source **(6)**.

Particulate emission factors for wind erosion of treated lands occurring after blading/piling were determined using source **(7)**, along with soil properties and readily available meteorological data. The meteorological data were processed using the PCRAMMET preprocessor to obtain the hourly friction velocities needed to calculate emission factors for TSP, PM_{10} and $PM_{2.5}$. Section 4.2 of the *Vegetation Treatment Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (PEIS) *Air Quality Impact Assessment Protocol* (ENSR 2004) further describes the PCRAMMET processing method that was used. Table 2-1 summarizes location characteristics that were used in PCRAMMET. Surface meteorological data for the 12 locations listed below, where blading/piling or exposed soils would occur, was obtained from the Solar and Meteorological Surface Observation Network (SAMSON) data set that has been produced by the National Climatic Data Center (as described online at http://nndc.noaa.gov/). After a review of available data, the most recent SAMSON year with complete surface and mixing height data were selected for each station. Mixing height data for these sites were obtained from the USEPA's "Technology Transfer Network Support Center for Regulatory Air Models" (see http://www.epa.gov/ttn/scram/).

- Arizona: 1990 AZ23160 Tucson/International Airport
- California: 1990 CA24257 Redding/Army Airfield (AAF)
- Colorado: 1990 CO 93037 Colorado Springs/Municipal
- Idaho: 1990 ID24131 Boise/Air Terminal
- Montana: 1990 MT94008 Glasgow/International Airport
- Nevada: 1985 NV24128 Winnemucca/Weather Services Office (WSO) Airport
- New Mexico: 1990 NM23050 Albuquerque/International Airport
- Eastern Oregon: 1989 OR24230 Redmond/Federal Aviation Administration (FAA) Airport
- Western Oregon: 1990 OR 24225 Medford/Jackson County Airport
- Utah: 1990 UT 24127 Salt Lake City/ International Airport
- Washington: 1990 WA24127 Spokane / International Airport
- Wyoming: 1990 WY 24021 Lander/Hunt Field

The following statewide average surface threshold friction velocities for undisturbed lands were assumed (Gillette 1988):

- Arizona: sandy loam; 290 cm/sec
- California: sandy loam; 290 cm/sec
- Colorado: loamy sand; 103 cm/sec
- Idaho: loamy sand; 103 cm/sec
- Montana: loamy sand; 103 cm/sec
- Nevada: sandy loam; 290 cm/sec
- New Mexico: sandy loam; 290 cm/sec

- Eastern Oregon: clay loam; 120 cm/sec
- Western Oregon: loam; 150 cm/sec
- Utah: sandy loam; 290 cm/sec
- Washington: loamy sand; 103 cm/sec
- Wyoming: loamy sand; 103 cm/sec

Exhaust emission factors for transportation vehicles were determined using vehicle data provided by the BLM and sources **(1)**, **(2)**, and **(3)**. Emission factors for the fugitive dust from the roads (assumed to be unpaved) were determined from trip mileage and soil properties provided by the BLM and source **(4)**.

Any other emissions that may occur during mowing or blading/piling activities were considered negligible and were not included in the annual emissions computations for each treatment alternative.

TABLE 2-1

Location Characteristics for Input to PCRAMMET (for Determination of Hourly Friction Velocities)

LOCATION	Land-use Type	Anemometer Height (m)	Applied Roughness Length (m)	Noon-Time Albedo	Bowen Ratio (Average Precipitation)
Tucson, Arizona	Desert shrubland	6.10	0.26	0.33	4.75
Redding, California	Desert shrubland	10.06	0.26	0.33	4.75
Colorado Springs, Colorado	Desert shrubland	6.71	0.26	0.33	4.75
Boise, Idaho	Grassland	6.10	0.04	0.29	0.83
Glasgow, Montana	Grassland	6.10	0.04	0.29	0.83
Winnemucca, Nevada	Desert shrubland	10.06	0.26	0.33	4.75
Albuquerque, New Mexico	Coniferous forest	7.01	1.30	0.18	0.83
Redmond, Oregon	Coniferous forest	6.10	1.30	0.18	0.83
Medford, Oregon	Coniferous forest	6.10	1.30	0.18	0.83
Salt Lake City, Utah	Coniferous forest	6.10	1.30	0.18	0.83
Spokane, Washington	Coniferous forest	6.10	1.30	0.18	0.83
Lander, Wyoming	Desert shrubland	9.75	0.26	0.33	4.75

2.3 Manual Treatment

Manual treatment of vegetation involves the use of hand-operated power tools and other hand tools to cut, clear, or prune undesired vegetation. Typical daily activities include the following:

- Hand pulling/cutting/shoveling of grasses, forbs, and small shrubs by five people for 5 consecutive days, beginning after 9 a.m. and ending by 5 PM each day, treating a total of 25 acres.
- Chainsaw cutting and hand clearing of woody shrubs and small trees shrubs by five people for 5 consecutive days, beginning after 9 a.m. and ending by 5 p.m. each day, treating a total of 25 acres.
- Transportation by 8-passenger van of all personnel to site.

Exhaust emission factors for transportation vehicles were determined using vehicle data provided by BLM and source **(1)**.

Emission factors for the fugitive dust from the roads (assumed to be unpaved) were determined from trip mileage and soil properties provided by the BLM and source **(4)**.

Vegetation cutting is assumed to utilize 4.1-hp (3.1-Kw) Phase 2, spark ignition handheld Class V chainsaws with the following emission rates (USEPA 2002):

CO – 283 gm/hp-hr
NO_x – 0.9 gm/hp-hr
TSP/PM_{10}/$PM_{2.5}$ – 7.7 gm/hp-hr
VOCs – 48 gm/hp-hr

Particulate emissions that may occur during hand pulling/cutting/shoveling were considered negligible and were not included in the annual emissions computations for each treatment alternative.

2.4 Biological Treatment

Biological control of vegetation involves the intentional use of grazing animals, plant eating insects, nematodes, mites, or pathogens that weaken or destroy vegetation. Typical daily activities include the following:

- Use of herbivores such as sheep or goats to consume target vegetation for 30 consecutive days, beginning after 9 a.m. and ending by 5 p.m. each day, treating a total of 300 acres.
- Hand release of insects (or other agents) at several points within the target area on one day, beginning after 9 a.m. and ending by 5 p.m. each day, treating a total of 100 acres.
- Vehicle transportation of all personnel, animals, and insects to the site using pick-up trucks and semi trucks with livestock trailers.

Exhaust emission factors were determined using vehicle data provided by the BLM and sources **(1)**, **(2)**, and **(3)**. Emission factors for the fugitive dust from the roads (assumed to be unpaved) were determined from trip mileage and soil properties provided by the BLM and source **(4)**. All other emissions that may occur during biological treatments were considered negligible and were not included in the annual emissions computations for each treatment alternative.

2.5 Chemical Treatment

Chemical treatment of vegetation involves the use of herbicides to kill or injure plants. Typical daily activities include the following:

- Aerial spraying of herbicide via airplane for one day beginning after 9 a.m. and ending by 5 p.m., treating a total of 1,000 acres.
- Aerial spraying of herbicide via helicopter for one day beginning after 9 a.m. and ending by 5 p.m., treating a total of 1,000 acres.
- Application of herbicide by pick-up truck sprayer for one day beginning after 9 a.m. and ending by 5 p.m., treating a total of 10 acres.
- Application of herbicide by all-terrain vehicle (ATV) sprayer for one day beginning after 9 a.m. and ending by 5 p.m., treating a total of 10 acres.

- Application of herbicide by backpack sprayer by five people for 2 consecutive days beginning after 9 a.m. and ending by 5 p.m., treating a total of 10 acres.

- Vehicle transportation of all personnel to site using cars, pick-up trucks, water trucks, and Flagger vehicles.

Exhaust emission factors were determined using vehicle data provided by the BLM and sources **(1)**, **(2)**, and **(3)**. Emission factors for the fugitive dust from the roads (assumed to be unpaved) were determined from trip mileage and soil properties provided by the BLM and source **(4)**. All other emissions that may occur during chemical treatments are considered negligible and were not included in the annual emissions computations for each treatment alternative.

3.0 DETERMINATION OF ANNUAL EMISSIONS BY STATE AND PROPOSED ALTERNATIVE

Five alternative actions, including the Preferred Alternative and No Action alternative, have been developed for evaluation in the PEIS and *Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (PER). Three of these alternatives (alternatives C, D, and E) are evaluated in the PEIS and relate strictly to herbicide use. The other two alternatives (alternatives A and B) incorporate all vegetation treatment methods and are evaluated in both the PEIS (herbicide treatments only) and the PER (all treatments). These alternatives address the public's desire to see less prescribed burning and herbicide use, while still meeting vegetation management objectives, and differ mainly in the number of acres treated under each of the five treatment methods discussed in Section 2. This section describes the annual level of activity in each state, under each alternative, and how the emission factors were applied to determine annual pollutant emissions. The actual emissions calculations are provided in the appendices.

3.1 Summary of Alternatives

- Alternative A – Continue Present Vegetation Treatment Activities. This is the No Action Alternative, under which the BLM would continue its ongoing vegetation treatment programs. This alternative includes restrictions on acres treated using prescribed fire and herbicides and on the types of herbicides used.

- Alternative B – Treat Vegetation on Up to 6 Million Acres Annually in 17 Western States (Preferred Alternative). Under the Preferred Alternative, the total number of acres treated would be three times the number currently treated. Relative to Alternative A, there would be fewer restrictions on acres treated using either prescribed fire or herbicides, as well as fewer constraints on the types of herbicides used.

- Alternative C – No Use of Herbicides. Under Alternative C, the BLM would not be able to treat vegetation using herbicides and would not be able to use new chemicals that are developed in the future. The BLM would be able to treat vegetation using fire, and mechanical, manual, and biological control methods.

- Alternative D – No Aerial Application of Herbicides. This alternative is similar to the Preferred Alternative in that it represents the treatment of vegetation using herbicides in 17 western states, including Alaska, and use of the same AIs as allowed under the Preferred Alternative. Under Alternative D, however, only ground-based techniques would be used to apply herbicides and no aerial applications of herbicides would be allowed; this would reduce the risk of spray drift impacting non-target areas.

- Alternative E – No Use of Sulfonylurea and other Acetolactate Synthase-inhibiting Active Ingredients. Under Alternative E, the BLM would not use sulfonylurea and other acetolactate synthase-inhibiting AIs approved in the earlier RODs, which are chlorsulfuron, imazapyr, metsulfuron methyl, and sulfometuron methyl. The BLM would be able to use 10 AIs in the 17 western states, including Alaska, that were approved for use in the earlier RODs and for which an analysis of their risks to humans and non-target plants and animals was evaluated for this PEIS. These AIs are: 2,4-D, bromacil, clopyralid, dicamba, diuron, glyphosate, hexazinone, picloram, tebuthiuron, and triclopyr. The six other AIs currently approved for use by the BLM—2,4-DP, atrazine, asulam, fosamine, mefluidide, and simazine—would not be used unless guidelines given for the Preferred Alternative were met. In addition, the BLM would be allowed to use three additional AIs in all 17 states: diquat, diflufenzopyr (if it becomes registered for herbicidal use), and fluridone. The BLM would also be able to use a formulation of diflufenzopyr and dicamba.

3.2 Estimated Treatment Acreage by State and Alternative

The following tables present the number of acres proposed for treatment in each of the 17 states under each of the five treatment methods, by applicable alternative action.

TABLE 3-1

Treatment Method and Estimated Acres Treated Annually for Each State - Alternative A

State	Treatment Method					Total
	Prescribed Fire	Mechanical	Manual	Biological	Chemical	
Alaska	57,756	250	2,514	0	0	60,520
Arizona	42,544	6,374	453	7,037	9,958	66,366
California	14,773	13,967	3,904	124,945	5,065	162,654
Colorado	25,807	47,115	5,752	3,525	7,765	89,964
Idaho	42,025	117,395	5,255	7,978	57,093	229,746
Montana	45,525	6,181	4,330	99,945	23,195	179,176
Nebraska	0	0	0	0	0	0
Nevada	55,817	196,702	8,320	2,500	24,972	288,311
New Mexico	100,796	1,550	5,422	450	96,616	204,834
North Dakota	0	80	5	544	8	637
Oklahoma	0	0	0	0	0	0
Oregon (Total)	126,770	112,431	60,185	2,965	20,958	323,309
Eastern	50,708	44,972	24,074	1,186	8,383	129,323
Western	76,062	67,459	36,111	1,779	12,575	193,986
South Dakota	83	1,866	3	290	1,032	3,274
Texas	11,433	0	0	0	0	11,433
Utah	30,500	64,725	16,387	1,000	21,662	134,274
Washington	6,320	1,080	525	760	1,940	10,625
Wyoming	85,068	12,187	440	1,113	35,129	133,937
Total	***645,217***	***581,903***	***113,495***	***253,052***	***305,393***	***1,899,060***

3.3 State-by-State Emissions Estimate Procedures

Annual emissions for CO, CO_2, TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb, and VOCs were estimated for each alternative action on a state-by-state basis, using the emission factors determined for each treatment method, as described in Section 2. Emissions were estimated using assumptions previously provided by the BLM (2003) and detailed below, in conjunction with the emission factors mentioned above in Section 2. Total annual emissions are based on the number of acres treated under each of the five methods, for each alternative action. The emission estimate procedures summarized below are organized by treatment method; assumptions are listed first, followed by emission calculation methods.

TABLE 3-2

Treatment Method and Estimated Acres Treated Annually for Each State - Alternative B

State	Treatment Method					Total
	Prescribed Fire	Mechanical	Manual	Biological	Chemical	
Alaska	140,000	5000	0	0	0	145,000
Arizona	201,490	27,540	1,080	16,940	36,300	283,350
California	17,260	23,650	4,630	183,470	5,620	234,630
Colorado	80,790	116,400	15,530	9,520	20,960	243,200
Idaho	198,600	391,810	36,640	55,750	258,990	941,790
Montana	37,290	18,480	4,440	156,990	53,160	270,360
Nebraska	0	0	0	0	0	0
Nevada	501,830	1,051,290	53,050	16,450	206,560	1,829,180
New Mexico	90,960	4,300	9,620	1,510	88,600	194,990
North Dakota	0	80	0	590	10	680
Oklahoma	0	0	0	0	0	0
Oregon (Total)	341,100	267,330	123,250	8,380	70,280	810,340
Eastern	136,440	106,932	49,300	3,352	28,112	324,136
Western	204,660	160,398	73,950	5,028	42,168	486,204
South Dakota	790	3,250	10	380	1,600	6,030
Texas	11,430	0	0	0	11,830	23,260
Utah	59,440	256,450	14,970	0	20,480	351,340
Washington	11,480	5,190	6,210	810	4,640	28,330
Wyoming	414,160	66,100	1,480	2,960	152,820	637,520
Total	***2,106,620***	***2,236,870***	***270,910***	***453,750***	***931,850***	***6,000,000***

TABLE 3-3

Estimated Acres Treated Annually using Herbicides for Each State for Alternatives C, D, and E

State	Treatment Alternative		
	C	D	E
Alaska	0	0	0
Arizona	0	23,595	18,147
California	0	3,935	2,809
Colorado	0	13,625	10,481
Idaho	0	168,345	129,481
Montana	0	34,555	26,577
Nebraska	0	0	0
Nevada	0	82,625	103,270
New Mexico	0	35,440	44,294
North Dakota	0	10	4
Oklahoma	0	0	0
Oregon (Total)	0	26,000	35,135
Eastern	0	10,400	21,080
Western	0	15,600	14,055
South Dakota	0	640	800
Texas	0	7,100	5,916
Utah	0	15,360	10,239
Washington	0	3,015	2,319
Wyoming	0	114,615	76,401
Total	***0***	*528,860*	***465,873***

3.3.1 Prescribed Fire Treatment Assumptions

3.3.1.1 Alaska

Prescribed Fire Assumptions:

- Fuel type: Mixed spruce and hardwoods
- Acres treated per event: 2,000 acres per day continuous for 5 days = 10,000 acres total
- Fire ignition and extinguishing: Wildland fire for resource benefit. Assume fire begins after 9 a.m. on first day and is extinguished by 6 p.m. on the fifth day.
- Fuel loading: 100 tons per acre
- Fuel combustion: 50%
- Combustion phases: 60% flaming, 40% smoldering from 9 a.m. until 6 p.m.; and 40% flaming, 60% smoldering from 6 p.m. until 9 a.m. the next day.

Fire Behavior Assumptions:

- 1-hr fuel moisture: 6%
- 10-hr fuel moisture: 7%
- Live woody fuel moisture: 100%
- Maximum rate of spread: 1,485 feet per hour (ft/hr)
- Heat content per unit area: 597 British Thermal Units (BTU)/ft^2
- Flame length: 5.7 ft

Transportation Vehicle Assumptions:

- It was assumed that no vehicles/roads were utilized.

3.3.1.2 Arizona

Prescribed Fire Assumptions:

- Fuel type: Desert shrub vegetation
- Acres treated per event: 500 acres per day on 4 separate days = 2,000 acres total
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 5 tons per acre
- Fuel combustion: 50%
- Combustion phases: 80% flaming, 20% smoldering

Fire Behavior Assumptions:

- 1-hr fuel moisture: 3%
- 10-hr fuel moisture: 4%
- 100-hr fuel moisture: 5%
- Maximum rate of spread: 3,016 ft/hr
- Heat content per unit area: 568 BTU/ft^2
- Fireline intensity: 476 BTU/ft^2
- Flame length: 7.7 ft

Transportation Vehicle Assumptions:

- Low altitude vehicle types: One 2-ton gasoline pick-up truck (4 wheels), five 5-ton diesel fire engines (6 wheels), one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph.
- Vehicle mileage: 50,000 miles.

Unpaved Road/Soil Assumptions:

- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 5%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.3 California

Prescribed Fire Assumptions:

- Fuel type: Chaparral vegetation.
- Acres treated per event: 200 acres per day on 3 separate days = 600 acres total.
- Fire ignition and extinguishing: Hand ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 40 tons per acre.
- Fuel combustion: 50%.
- Combustion phases: 80% flaming, 20% smoldering.

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Four 2-ton gasoline pick-up trucks (4 wheels), ten 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 5%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.4 Colorado

Prescribed Fire Assumptions:

- Fuel type: Sagebrush vegetation
- Acres treated per event: 300 acres per day on 2 separate days = 600 acres total
- Fire ignition and extinguishing: Hand ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 6 tons per acre
- Fuel combustion: 50%
- Combustion phases: 80% flaming, 20% smoldering

Transportation Vehicle Assumptions:

- High altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), and five 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.5 Idaho

Prescribed Fire Assumptions:

- Fuel type: Grass vegetation
- Acres treated per event: 1,000 acres per day on 3 separate days = 3,000 acres total
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 2 tons per acre
- Fuel combustion: 90%
- Combustion phases: 100% flaming

Transportation Vehicle Assumptions:

- Low altitude vehicle types: One 2-ton gasoline pick-up truck (4 wheels), seven 5-ton diesel fire engines (6 wheels), one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.6 Montana

Prescribed Fire Assumptions:

- Fuel type: Perennial Grass Vegetation
- Acres treated per event: 500 acres per day on 5 separate days = 2,500 acres total
- Fire ignition and extinguishing: Hand ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 2.5 tons per acre
- Fuel combustion: 90%
- Combustion phases: 100% flaming

Fire Behavior Assumptions:

- 1-hr fuel moisture: 3%
- Maximum rate of spread: 7,887 ft/hr
- Heat content per unit area: 103 BTU/ft^2
- Fireline intensity: 226 BTU/ft^2
- Flame length: 5.4 ft

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Four 2-ton gasoline pick-up trucks (4 wheels) and five 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 10%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.7 Nevada

Prescribed Fire Assumptions:

- Fuel type: Shrub vegetation.
- Acres treated per event: 700 acres per day on 6 separate days = 4,200 acres total.
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 6 tons per acre.
- Fuel combustion: 50%
- Combustion phases: 80% flaming, 20% smoldering
- Fire Behavior Assumptions:
- 1-hr fuel moisture: 3%
- 10-hr fuel moisture: 4%

- 100-hr fuel moisture: 5%
- Maximum rate of spread: 3,016 ft/hr
- Heat content per unit area: 568 BTU/ft^2
- Fireline intensity: 476 BTU/ft^2
- Flame length: 7.7 ft

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), four 5-ton diesel fire engines (6 wheels), one 100-ton diesel semi truck (18 wheels), one 5-ton diesel helicopter service truck (6 wheels), helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Pre-treatment and Post-treatment Assumptions:

- Pre-treatment activities/duration: One 50-ton D7 class bulldozer (road blader) with 10-ft blade delivered via semi truck. Bulldozer is assumed to have a 400-hp engine. Bulldozer operates for 4 hours at 15 mph over the course of 6 days. Bulldozer is left on-site nightly until fire treatment is completed.
- Post-treatment activities/duration: Bulldozer retrieved via semi truck. Wind erosion potentially occurs from 2.5 acres of disturbed soil for 3 months after fire treatment is completed.
- Unpaved Road/Soil Assumptions:
- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 5%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.8 New Mexico

Prescribed Fire Assumptions:

- Fuel type: bulldozed pinyon-juniper vegetation
- Acres treated per event: 500 acres per day on 6 separate days = 3,000 acres total
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 22 tons per acre
- Fuel combustion: 40%

- Combustion phases: 50% flaming, 50% smoldering

Transportation Vehicle Assumptions:

- High altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), five 5-ton diesel fire engines (6 wheels), one 100-ton diesel semi truck (18 wheels), one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Pre-treatment and Post-treatment Assumptions:

- Pre-treatment activities/duration: One 50-ton D7 class bulldozer with brush blade and root plow delivered via semi truck. Bulldozer is assumed to have a 400-hp engine. Bulldozer operates for twenty 8-hour days at 15 mph prior to any fire treatment. Bulldozer is left on-site nightly until fire treatment is completed.
- Post-treatment activities/duration: Bulldozer retrieved via semi truck. Wind erosion potentially occurs from 3,000 acres of disturbed soil for 3 months after fire treatment is completed.

Unpaved Road/Soil Assumptions:

- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.9 North Dakota

- No prescribed fire treatments

3.3.1.10 Oklahoma

- No prescribed fire treatments

3.3.1.11 Western Oregon (60% of total Oregon acreage)

Prescribed Fire Assumptions:

- Fuel type: Douglas-fir and hemlock logging slash
- Acres treated per event: 50 acres per day on 2 separate days = 100 acres total
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins at 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 80 tons per acre
- Fuel combustion: 25%.

- Combustion phases: 50% flaming, 50% smoldering

Fire Behavior Assumptions:

- 1-hr fuel moisture: 6%
- 10-hr fuel moisture: 7%
- 100-hr fuel moisture: 8%
- Maximum rate of spread: 455 ft/hr
- Heat content per unit area: 3,244 BTU/ft^2
- Fireline intensity: 411 BTU/ft^2
- Flame length: 7.2 ft

Transportation Vehicle Assumptions (During Treatment):

- Low altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), four 5-ton diesel fire engines (6 wheels), one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Pre-treatment and Post-treatment Vehicle Assumptions:

- Low altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels)
- Duration: 4 days pre-treatment, 2 days post-treatment
- All other vehicle assumptions were the same as during treatment.

Unpaved Road/Soil Assumptions:

- Soil type: Loam
- Silt content: 25%
- Soil moisture: 15%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.12 Eastern Oregon – 40% of total Oregon acreage

Prescribed Fire Assumptions:

- Fuel type: Ponderosa Pine Understory Vegetation
- Acres treated per event: 250 acres per day on 4 separate days = 1,000 acres total

- Fire ignition and extinguishing: Hand ignition. Assume fire begins at 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 4 tons per acre
- Fuel combustion: 50%.
- Combustion phases: 80% flaming, 20% smoldering

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Three 2-ton gasoline pick-up trucks (4 wheels) and three 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Clay loam
- Silt content: 10%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.13 South Dakota

Prescribed Fire Assumptions:

- Fuel type: Perennial Grass Vegetation
- Acres treated per event: 200 acres on 1 day = 200 acres total
- Fire ignition and extinguishing: Hand ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 2.5 tons per acre
- Fuel combustion: 90%
- Combustion phases: 100% flaming

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels) and one 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 10%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.14 Texas

Prescribed Fire Assumptions:

- Fuel type: Mixed shrub vegetation
- Acres treated per event: 750 acres per day on 2 separate days = 1,500 acres total
- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 6 tons per acre
- Fuel combustion: 50%
- Combustion phases: 80% flaming, 20% smoldering

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), five 5-ton diesel fire engines (6 wheels), and one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 10%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.15 Utah

Prescribed Fire Assumptions:

- Fuel type: Bulldozed pinyon-juniper vegetation
- Acres treated per event: 500 acres per day on 6 separate days = 3,000 acres total

- Fire ignition and extinguishing: Aerial ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 22 tons per acre
- Fuel combustion: 40%
- Combustion phases: 50% flaming, 50% smoldering

Transportation Vehicle Assumptions:

- High altitude vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels), five 5-ton diesel fire engines (6 wheels), one 100-ton diesel semi truck (18 wheels), one 5-ton diesel helicopter service truck (6 wheels). Helicopter emissions (during aerial ignitions) were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Pre-treatment and Post-treatment Assumptions:

- Pre-treatment activities/duration: One 50-ton D7 class bulldozer with brush blade and root plow delivered via semi truck. The 50-ton bulldozers assumed to have a 400-hp engine. Bulldozer operates for twenty 8-hour days at 15 mph prior to any fire treatment. Bulldozer is left on-site nightly until fire treatment is completed.
- Post-treatment activities/duration: Bulldozer retrieved via semi truck. Wind erosion potentially occurs from 3,000 acres of disturbed soil for 3 months after fire treatment is completed.

Unpaved Road/Soil Assumptions:

- Soil type: Sandy loam
- Silt content: 12%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.16 Washington

Prescribed Fire Assumptions:

- Fuel type: Ponderosa pine understory vegetation
- Acres treated per event: 250 acres per day on 4 separate days = 1,000 acres total
- Fire ignition and extinguishing: Hand ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 4 tons per acre
- Fuel combustion: 50%
- Combustion phases: 80% flaming, 20% smoldering

Transportation Vehicle Assumptions:

- Low altitude vehicle types: Three 2-ton gasoline pick-up trucks (4 wheels) and three 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 10%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.1.17 Wyoming

Prescribed Fire Assumptions:

- Fuel type: Mixed shrub vegetation
- Acres treated per event: 750 acres per day on 4 separate days = 3,000 acres total
- Fire ignition and extinguishing: Terra torch ignition. Assume fire begins after 9 a.m. and is extinguished by 6 p.m. on each day.
- Fuel loading: 6 tons per acre
- Fuel combustion: 50%
- Combustion phases: 50% flaming, 50% smoldering

Fire Behavior Assumptions:

- 1-hr fuel moisture: 3%
- 10-hr fuel moisture: 4%
- 100-hr fuel moisture: 5%
- Live woody fuel moisture: 100%
- Maximum rate of spread: 3,016 ft/hr
- Heat content per unit area: 568 BTU/ft^2
- Fireline intensity: 476 BTU/ft^2
- Flame length: 7.7 ft

Transportation Vehicle Assumptions:

- High altitude vehicle types: Three 2-ton gasoline pick-up trucks (4 wheels) and five 5-ton diesel fire engines (6 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Ignition Vehicle Assumptions:

- High altitude vehicle types: One 5-ton terra torch truck (6 wheels; used for ignition)
- Vehicle speed: 10 mph
- Vehicle mileage: 50,000 miles
- Vehicle operation: 6 hours per day

Unpaved Road/Soil Assumptions:

- Soil type: Loamy sand
- Silt content: 8%
- Soil moisture: 8%
- Road length (round-trip distance per transportation vehicle daily): 30 miles

3.3.2 Prescribed Fire Treatment Emissions Calculations

To estimate the average annual emissions from prescribed fire treatment, ENSR first determined the annual number of treatment events for each state. An "event" included all emissions from the example scenarios provided by the BLM. For example, a treatment event for Alaska included emissions from 10,000 total acres burned over 5 days, while an event for Arizona included emissions from 2,000 total acres burned over 4 days. The number of treatment events per year was calculated by dividing the estimated annual acreage for prescribed fire treatment in each state under each alternative (from Tables 3-1 to 3-2) by the total acreage per event. The annual emissions from prescribed fire treatment for each state were determined as follows:

Prescribed Fire Emissions:

The prescribed fire treatment assumptions for each state were used with the equation below **(EQN 1)** (found in Chapter 5 of National Wildfire Coordination Group (NWCG) 2001) to determine the flaming and smoldering emissions from prescribed fire for a single treatment event. Emissions for each of the two combustion phases were added together to determine the total emissions for each event. Next, to determine the annual emissions from prescribed fire, the emissions for a single event were multiplied by the annual number of treatment events in each state.

(EQN 1)
Fire Emissions (pounds; lbs) = Fuel Consumed[1] (tons/acre) x Emission Factor (lbs/ton) x Area Burned (acres)

Exhaust Emissions from Transportation and Fire Ignition Vehicles:

The vehicle assumptions for each state were used with the equation below **(EQN 2)** to calculate the amount of pollutant emissions from vehicle exhaust for a single treatment event. Unless otherwise noted above, it was assumed that each vehicle travels to and from the site once per day, for the duration of the treatment event. Next, to determine the annual emissions, the exhaust emissions for a single event were multiplied by the annual number of treatment events in each state.

(EQN 2)
Exhaust Emissions (grams) = Emission Factor (grams/mile) x Trip Distance (miles)

Particulate Emissions from Unpaved Roads:

The unpaved road/soil assumptions for each state were used with the equation below **(EQN 3)** to calculate the particulate emissions from the fugitive dust that occurs during vehicle transportation on unpaved roads during a single treatment event. Unless otherwise noted in the assumptions listed in Section 3.3.1, it was assumed that each vehicle travels to and from the treatment site once per day, for the duration of the treatment event. Next, to determine the annual emissions from unpaved roads, the emissions for a single event were multiplied by the annual number of treatment events per state, for each of the six alternative actions.

(EQN 3)
Unpaved Road Emissions (lbs) = Emission Factor (lbs/VMT) x Trip Distance (VMT in miles)

Exhaust Emissions from Bulldozers (Road Bladers):

The pre-treatment and post-treatment assumptions for each state were used with the equation below **(EQN4)** to calculate the emissions from the exhaust of bulldozers used during a single treatment event. To determine the annual emissions, the emissions for a single event were multiplied by the annual number of events per state.

(EQN 4)
Exhaust Emissions (grams) = Emission Factor (grams/horsepower-hour [hp-hr]) x Operation time (hours) x Engine Horsepower (hp)

Particulate Emissions during Bulldozing:

The pre-treatment and post-treatment assumptions for each state were used with the equation below **(EQN 5)** to calculate the particulate emissions from fugitive dust that occurs during bulldozing for a single event. To determine the annual emissions, the emissions for each event were multiplied by the annual number of events per state.

(EQN 5)
Dust Emissions (lbs) = Emission Factor (lbs/hr) x Operation time (hours)

[1] It is assumed that under flaming or smoldering conditions:
Fuel Consumed (tons/acre) = Fuel Loading (tons/acre) x % Fuel Combustion x % Flaming/Smoldering

Particulate Emissions after Bulldozing:

The particulate emissions occurring from disturbed soil after bulldozing were determined for a single treatment event using the post-treatment assumptions and meteorological data for each state. For every hour of meteorological data, it was determined whether windblown emissions were possible, using the restrictions noted from source **(7)**. The 3-month period containing the maximum hourly particulate emissions represented the "reasonable, but conservative" period used to determine the total fugitive dust emissions due to wind erosion of the disturbed soil. Emissions from each of the hours were then summed, representing the total emissions (gm/m^2) of fugitive dust during the scheduled 3-month period due to wind erosion. Next, **(EQN 6)** below was used to determine the total emissions of fugitive dust for each activity. To determine the annual emissions, the emissions for a single activity were multiplied by the annual number of activities per state.

(EQN 6)
Dust Emissions (grams) = Emissions from a 3-month period (gm/m^2) x Disturbed Area (square meter [m^2])

Total Annual Prescribed Fire Treatment Emissions:

For each state and alternative action, the annual pollutant emissions from fire, vehicle exhaust (from transportation vehicles and bulldozers), and fugitive dust (from unpaved roads, bulldozing, and disturbed soil) were converted to tons and summed, yielding the total number of tons per year emitted from prescribed fire treatment.

3.3.3 Mechanical Treatment Assumptions

Mowing Assumptions (all states):

- Vegetation type: Grasses, forbs, and small shrubs
- Acres treated per event: 100 acres per two 8 hour days = 100 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day
- Operation assumptions: Day 1 - Travel to/from site in one pick-up truck, towing tractor. Mow for 8 hours, using a 2-ton 70 horsepower diesel tractor. Day 2 – Travel to/from site in one pick-up truck, towing tractor. Drill seed for 8 hours, using a 2-ton, 70-horsepower diesel tractor.

Transportation Vehicle Assumptions For Mowing (All States):

- Elevation assumptions: High altitude assumed for Colorado, New Mexico, Utah, and Wyoming. Low altitude assumed for all other states.
- Vehicle types: One 2-ton gasoline pick-up truck with trailer (4 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Brush Blading/Piling Assumptions (All States):

- Vegetation type: Shrubs and small trees
- Acres treated per event: 6 acres per day for 17 days = 102 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.

- Pre-treatment assumptions: One 50-ton D7 class diesel bulldozer and one 25-ton, 3-yd diesel articulating loader delivered via semi truck in separate trips. Bulldozer assumed to have a 400-hp engine. Articulating loader assumed to have a 200-hp engine. Bulldozer and loader were left on-site nightly until treatment was completed.

- Daily operations: Travel to site using two pick-up trucks. First 4 hours – D7 bulldozer operated brush blade, while articulating loader operated brush rake, both operated on 3 acres. Second 4 hours – D7 bulldozer operated root plow, while articulating loader piled materials, both operated on the next 3 acres. Return from site using two pick-up trucks.

- Post-treatment assumptions: Bulldozer and loader were retrieved via semi truck in separate trips. Travel to site in pick-up truck with tractor in tow, operate tractor for 8 hours, return from site with tractor in tow. Wind erosion potentially occurs from 102 acres of disturbed soil for 3 months after fire treatment is completed.

Transportation Vehicle Assumptions For Blading/Piling (All States):

- Elevation assumptions: High altitude assumed for Colorado, New Mexico, Utah, and Wyoming. Low altitude assumed for all other states.

- Vehicle types: Two 2-ton gasoline pick-up trucks with trailer (4 wheels) and one 100-ton diesel semi truck (18 wheels)

- Vehicle speed: 30 mph

- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions For Both Mowing and Blading/Piling (All States):

- Soil assumptions: Soil type, silt content, and soil moisture used for each state were the same as that stated above in Section 3.3.1.

- Road length (round-trip distance per transportation vehicle daily): 30 miles

Mechanical Treatment Methods By State:

- Alaska, North Dakota, South Dakota: 100% mowing, no blading/piling

- Arizona, California, Colorado, Idaho, Montana, Nevada, Eastern Oregon, Western Oregon, Utah, Washington, Wyoming: 95% mowing, 5% blading/piling

- New Mexico: 50% mowing, 50% blading/piling

- Oklahoma, Texas: No mechanical treatments assumed.

3.3.4 Mechanical Treatment Emissions Calculations

To estimate the average annual emissions by mechanical treatment for each state, ENSR first determined the amount of annual acres treated by each of the two mechanical methods (mowing and blading/piling). The number of acres treated by each method was calculated by taking the appropriate percentages, shown above, of the total number of mechanical treatment acres for each state and alternative action (from Tables 3-1 and 3-2). To calculate the annual number of mowing events for each state, the annual number of acres treated by mowing was divided by 100 (the total acreage per single event). The same process was used to calculate the annual number of blading/piling events. The annual emissions from mowing and blading/piling treatments for each state were determined as follows:

Exhaust Emissions from Transportation Vehicles:

To calculate the amount of pollutant emissions due to exhaust from transportation vehicles, the assumptions stated above were used with **(EQN 2)** to first calculate emissions for a single mowing event and a single blading/piling event. Unless otherwise noted above, it was assumed that each vehicle travels to and from the treatment site once per day, for the duration of each event. Next, to determine the annual emissions due to each method, the exhaust emissions for a single event were multiplied by the annual number of mowing and blading/piling events in each state.

Particulate Emissions from Unpaved Roads:

To calculate the particulate emissions from unpaved roads, the assumptions stated above were used with **(EQN 3)** to first calculate emissions for a single mowing event and a single blading/piling event. As stated above, normally it was assumed that each vehicle travels to and from site once per day, for the duration of each event. Next, to determine the annual emissions from each method, the emissions for a single event were multiplied by the annual number of mowing and blading/piling events in each state.

Exhaust Emissions from Bulldozers, Tractors, and Articulating Loaders:

The above assumptions were used with **(EQN 4)** to calculate the emissions from the exhaust of the vehicles used during a single mowing event and a single blading/piling event. Next, to determine the annual emissions, the emissions for a single event were multiplied by the annual number of mowing and blading/piling events in each state.

Particulate Emissions during Blading/Piling:

The above assumptions were used with **(EQN 5)** to first calculate the particulate emissions from fugitive dust that occurs during blading/piling for a single event. Next, to determine the annual emissions, the emissions for each event were multiplied by the annual number of blading/piling events per state.

Particulate Emissions after Bulldozing:

The particulate emissions occurring from disturbed soil after bulldozing were determined for a single treatment event using the post-treatment assumptions and meteorological data for each state. For every hour of meteorological data, it was determined whether windblown emissions were possible, using the restrictions noted from source **(7)**. The 3-month period containing the maximum hourly particulate matter emissions represented the "reasonable, but conservative" period used to determine the total fugitive dust emissions from wind erosion of the disturbed soil. Emissions from each of the hours were then summed, representing the total emissions (gm/m^2) of fugitive dust during the scheduled 3-month period due to wind erosion. Next, **(EQN 6)** was used to determine the total emissions of fugitive dust for each activity. To determine the annual emissions, the emissions for a single activity were multiplied by the annual number of activities per state.

Total Annual Mechanical Treatment Emissions:

The annual pollutant emissions due to mechanical treatments from vehicle exhaust (from transportation vehicles and operational vehicles) and fugitive dust (from unpaved roads and disturbed soil) were converted to tons and summed for each state. The resulting annual mechanical treatment emissions were then summed, yielding the total number of tons per year emitted from mechanical treatment.

3.3.5 Manual Treatment Assumptions

Hand Pulling/Cutting/Shoveling Assumptions (all states):

- Vegetation type: Grasses, forbs, and small shrubs

- Acres treated per event: 5 acres per 5 people/ 8 hours over 5 days = 25 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: Five employees travel to/from site by 8-passenger van each day to hand pull vegetation.

Cutting and Clearing Assumptions (all states):

- Vegetation type: Woody shrubs and small trees.
- Acres treated per event: 5 acres per 5 people/ 8 hours over 5 days = 25 acres total.
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Pre-treatment assumptions: One employee travels to/from site by pick-up truck to mark material to be cut and cleared for each day of treatment.
- Daily operations: Five employees travel to/from site by 8-passenger van each day to cut vegetation, assuming use of 4.1 hp (3.1 Kilowatt [Kw]) Phase 2, spark engine handheld Class V chainsaws.

Transportation Vehicle Assumptions (All States):

- Vehicle types: One 2-ton gasoline 8-passenger van (4 wheels) for hand pulling operations, and one 2-ton gasoline 8-passenger van (4 wheels) for cutting operations, plus one 2-ton gasoline pick-up truck (4 wheels) for cutting pre-treatment
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions (All States):

- Soil assumptions: Soil type, silt content, and soil moisture used for each state were the same as that stated above in Section 3.3.1.
- Road length (round-trip distance per transportation vehicle daily): 30 miles

Manual Treatment Methods By State:

- Alaska, Western Oregon, Washington: 10% hand pulling/cutting/shoveling, 90% cutting and clearing
- Colorado, Idaho: 20% hand pulling/cutting/shoveling, 80% cutting and clearing
- Eastern Oregon, Utah: 40% hand pulling/cutting/shoveling, 60% cutting and clearing
- Arizona, California, Montana, New Mexico, Nevada, Wyoming: 50% hand pulling/cutting/shoveling, 50% cutting and clearing
- North Dakota, South Dakota: 100% hand pulling/cutting/shoveling, no cutting and clearing
- Oklahoma, Texas: No manual treatments assumed.

3.3.6 Manual Treatment Emissions Calculations

To estimate the annual emissions resulting from manual treatment for each state, ENSR first determined the amount of annual acres treated by each of the two manual methods (hand pulling/cutting/shoveling and cutting/clearing). The number of acres treated by each method was calculated by taking the appropriate percentages, shown above, of the total number of manual treatment acres for each state and alternative action (from Tables 3-1 and 3-2). To calculate the annual number of hand pulling/cutting/shoveling events for each state, the annual number of acres treated was divided by 25 (the total acreage per single event). The same process was used to calculate the annual number of cutting/clearing events. The annual emissions from manual treatments for each state were determined as follows:

Exhaust Emissions from Transportation Vehicles and Chainsaws:

To calculate the amount of pollutant emissions due to exhaust from transportation vehicles, the assumptions stated above were used with **(EQN 2)** to first calculate emissions for a single hand pulling/cutting/shoveling event and a single cutting/clearing event. Unless otherwise noted above, it was assumed that each vehicle travels to and from the treatment site once per day, for the duration of each event. In addition, exhaust emissions from chainsaw use were also calculated using **(EQN 7)** below. To determine the annual emissions due to each method, the exhaust emissions for a single event were multiplied by the annual number of events per state for each method, for each of the six alternative actions.

(EQN 7)
Chainsaw Exhaust Emissions (grams) = Emission Factor (grams/hp-hr) x Engine Power (hp) x Operation time (hours)

Particulate Emissions from Unpaved Roads:

To calculate the particulate emissions from unpaved roads, the assumptions stated above were used with **(EQN 3)** to first calculate emissions for a single hand pulling/cutting/shoveling event and a single cutting/clearing event. As stated above, normally it was assumed that each vehicle travels to and from the site once per day, for the duration of each event. To determine the annual emissions from each method, the emissions for a single event were multiplied by the annual number of events per state.

Total Annual Manual Treatment Emissions:

The annual pollutant emissions from vehicle and chainsaw exhaust and fugitive dust were converted to tons and summed for both methods, for each state. The resulting annual hand pulling/cutting/shoveling emissions and cutting/clearing emissions were then summed, yielding the total number of tons per year emitted from manual treatment.

3.3.7 Biological Treatment Assumptions

Herbivore (Sheep/Goats) Assumptions (all states):

- Acres treated per event: 10 acres per day over 30 days = 300 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Pre-treatment And Post-treatment assumptions: One employee travels to/from site by pick-up truck, drives on-site for one mile at 15 mph to install/remove electric fence. Grazing livestock delivered/retrieved via semi truck with livestock trailer.
- Daily operations: One employee travels to/from site by pick-up truck with horse trailer, drives on-site for one mile at 15 mph to move fence and animals, each day during treatment.

Hand Release of Insects Assumptions (all states):

- Acres treated per event: 100 acres per 1 person per 1 day = 100 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: One employee travels to/from site by pick-up truck, drives on-site for two miles at 15 mph to various release points.

Transportation Vehicle Assumptions (all states):

- Elevation assumptions: High altitude assumed for Colorado, New Mexico, Utah, and Wyoming. Low altitude assumed for all other states.
- Vehicle types: One 2-ton gasoline pick-up truck with horse trailer (4 wheels) and one 50-ton diesel semi truck with livestock trailer (18 wheels)
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions (all states):

- Soil assumptions: Soil type, silt content, and soil moisture used for each state were the same as that stated above in Section 3.3.1.
- Road length (round-trip distance per transportation vehicle daily): 30 miles

Biological Treatment Methods By State:

- North Dakota, South Dakota: 100% herbivores, no insects
- Colorado, New Mexico, Western Oregon, Washington, Wyoming: 90% herbivores, 10% insects
- Arizona, Idaho: 80% herbivores, 20% insects
- Montana: 70% herbivores, 30% insects
- Eastern Oregon: 60% herbivores, 40% insects
- California, Nevada: 50% herbivores, 50% insects
- Alaska, Oklahoma, Texas, Utah: No biological treatments assumed

3.3.8 Biological Treatment Emissions Calculations

To estimate the annual emissions resulting from biological treatment for each state, ENSR first determined the amount of annual acres treated by each of the two biological methods (herbivores and hand release of insects). The number of acres treated by each method was calculated by taking the appropriate percentages, shown above, of the total number of biological treatment acres for each state and alternative action (from Tables 3-1 to 3-2). To calculate the annual number of herbivore events for each state, the annual number of acres treated was divided by the total acreage per single event. The same process was used to calculate the annual number of hand release of insects events. The annual emissions from biological treatments for each state were determined as follows:

Exhaust Emissions from Transportation Vehicles:

To calculate the amount of pollutant emissions due to exhaust from transportation vehicles, the assumptions stated above were used with **(EQN 2)** to first calculate emissions for a single herbivore event and a single hand release of insects event. Unless otherwise noted above, it was assumed that each vehicle travels to and from the treatment site once per day, for the duration of each event. Next, to determine the annual emissions from each method, the exhaust emissions for a single event were multiplied by the annual number of events per state for each method.

Particulate Emissions from Unpaved Roads:

To calculate the particulate emissions from unpaved roads, the assumptions stated above were used with **(EQN 3)** to first calculate emissions for a single herbivore event and a single hand release of insects event. Unless stated above, it was assumed that each vehicle travels to and from the treatment site once per day, for the duration of each event. To determine the annual emissions from each method, the emissions for a single event were multiplied by the annual number of events per state for each method.

Total Annual Biological Treatment Emissions:

The annual pollutant emissions from vehicle exhaust and fugitive dust were converted to tons and summed for both methods, for each state. The resulting annual herbivore emissions and annual emissions due to hand release of insects were then summed, yielding the total number of tons per year emitted from biological treatment.

3.3.9 Chemical Treatment Assumptions

Airplane Aerial Spraying Assumptions (all states):

- Acres treated per event: 1,000 acres per one day = 1,000 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: Four employees travel to/from site in two pick-up trucks, then drive on-site for two miles at 15 mph.

Helicopter Aerial Spraying Assumptions (all states):

- Acres treated per event: 1,000 acres per one day = 1,000 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: Four employees travel to/from site in two pick-up trucks, then drive on-site for two miles at 15 mph. One employee travels to/from site in helicopter service truck.

Pick-Up Truck Spraying Assumptions (all states):

- Acres treated per event: 10 acres per 2 people/ 8 hr over one day = 10 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: One employee travels to/from site in pick-up truck with sprayer, truck drives on-site spraying 10 acres over 8 hrs traveling at 10 mph. One employee travels to/from site in water truck.

ATV Spraying Assumptions (all states):

- Acres treated per event: 10 acres per 2 people/ 8 hr over one day = 10 acres total

- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: Two employee travels to/from site in pick-up truck with ATV trailer, two ATVs drive on-site spraying 10 acres over 8 hrs traveling at 10 mph.

Back-Pack Spraying Assumptions (all states):

- Acres treated per event: 5 acres per 5 people/ 8 hr over two days = 10 acres total
- Operation hours: Assume treatment begins after 9 a.m. and is completed by 5 p.m. each day.
- Daily operations: Five employees travel to/from site in 8-passenger van for two days.

Transportation Vehicle Assumptions (all states):

- Elevation assumptions: High altitude assumed for Colorado, New Mexico, Utah, and Wyoming. Low altitude assumed for all other states.
- Vehicle types: Two 2-ton gasoline pick-up trucks (4 wheels) for airplane aerial spraying, two 2-ton gasoline pick-up trucks (4 wheels) and one 5-ton diesel helicopter service truck (6 wheels) for helicopter aerial spraying , one 2-ton gasoline pick-up truck (4 wheels) and one 5-ton diesel water truck (6 wheels) for pick-up truck spraying, one 2-ton gasoline pick-up truck (4 wheels) with trailer and two 400 cc, 500 lb gasoline ATVs (4 wheels) for ATV spraying, and one 2-ton gasoline 8-passenger van (4 wheels) for back-pack spraying.
- Emissions from airplanes and helicopters were considered negligible.
- Vehicle speed: 30 mph
- Vehicle mileage: 50,000 miles

Unpaved Road/Soil Assumptions (all states):

- Soil assumptions: Soil type, silt content, and soil moisture used for each state were the same as that stated above in Section 3.3.1.
- Road length (round-trip distance per transportation vehicle daily): 30 miles

Chemical Treatment Methods By State:

- Arizona, Colorado, Idaho, Montana, Eastern Oregon, Washington: 20% airplane aerial spraying, 15% helicopter aerial spraying, 20% pick-up truck spraying, 20% ATV spraying, and 25% back-pack spraying.
- California: 15% airplane aerial spraying, 15% helicopter aerial spraying, 20% pick-up truck spraying, 20% ATV spraying, and 30% back-pack spraying .
- Nevada, New Mexico, South Dakota: 40% airplane aerial spraying, 20% helicopter aerial spraying, 10% pick-up truck spraying, 10% ATV spraying, and 20% back-pack spraying.
- North Dakota: 50% ATV spraying and 50% back-pack spraying
- Western Oregon: 10% airplane aerial spraying, 10% helicopter aerial spraying, 15% pick-up truck spraying, 15% ATV spraying, and 50% back-pack spraying.

- Texas: 20% airplane aerial spraying, 20% helicopter aerial spraying, 20% pick-up truck spraying, 20% ATV spraying, and 20% back-pack spraying.

- Utah, Wyoming: 15% airplane aerial spraying, 10% helicopter aerial spraying, 25% pick-up truck spraying, 25% ATV spraying, and 25% back-pack spraying.

- Alaska, Oklahoma: No chemical treatments assumed.

3.3.10 Chemical Treatment Emissions Calculations

To estimate the annual emissions resulting from chemical treatment for each state, ENSR first determined the amount of annual acres treated by each of the five chemical spraying methods. The number of acres treated by each method was calculated by taking the appropriate percentages, as shown in Section 3.3.9, of the total number of chemical treatment acres for each state and for each alternative action (from Tables 3-1 to 3-3). To calculate the annual number of events for each method per state, the annual number of acres treated was divided by the total acreage per single event. The annual emissions from chemical treatments for each state were determined as follows:

Exhaust Emissions from Transportation Vehicles:

To calculate the amount of pollutant emissions due to exhaust from transportation vehicles, the assumptions stated in Section 3.3.9 were used with **(EQN 2)** to first calculate emissions for a single event, for each of the five chemical spraying methods. It was assumed that each vehicle travels to and from the treatment site once per day, for the duration of each event. Next, to determine the annual emissions from each treatment method, the exhaust emissions for a single event were multiplied by the annual number of events per state for each method.

Particulate Emissions from Unpaved Roads:

To calculate the particulate emissions from unpaved roads, the assumptions stated above were used with **(EQN 3)** to first calculate emissions for single event, for each of the five methods. To determine the annual emissions due to each method, the emissions for a single event were multiplied by the annual number of events per state for each method.

Total Annual Chemical Treatment Emissions:

The annual pollutant emissions from vehicle exhaust and fugitive dust were converted to tons and summed for each method, for each state and alternative action. The resulting annual emissions for each method were then summed, yielding the total number of tons per year emitted from chemical treatment.

4.0 SUMMARY OF ANNUAL AVERAGE AIR POLLUTANT EMISSIONS BY STATE AND ALTERNATIVE

Based on the proposed number of acres to be treated in each of the 17 states under each alternative action (listed in Tables 3-1 to 3-3), the average annual pollutant emissions from each of the five treatment methods were determined using the assumptions and procedures outlined in Sections 2 and 3. The annual emissions are presented for each alternative action (in tons of pollutant) in Tables 4-1 to 4-13 below. It should be noted that because the proposed number of acres to be treated in each state under each alternative action is subject to change, so are the estimated annual emissions summarized below, as they are directly dependant on the number of acres treated.

TABLE 4-1

Annual Emissions Summary for Prescribed Fire Treatment under the No Action Alternative (Alternative A)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	340,544	4,375,234	5,920	29,311	29,311	26,106	57	2,397	19,319
Arizona	8,892	170,027	915	1,669	1,668	1,523	3	88	587
California	20,033	472,322	2,541	2,696	2,695	2,246	3	245	1,631
Colorado	6,473	123,765	666	1,215	1,214	1,109	2	64	427
Idaho	14,184	312,036	662	1,627	1,626	1,381	2	157	908
Montana	7,683	169,012	359	882	881	748	1	85	492
Nebraska	0	0	0	0	0	0	0	0	0
Nevada	14,000	267,761	1,442	2,630	2,626	2,398	4	139	924
New Mexico	73,629	1,350,815	1,896	30,467	19,789	12,647	13	739	5,854
North Dakota	0	0	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
Oregon (Total)	237,787	2,476,690	3,471	17,708	17,668	16,423	37	1,347	10,601
Eastern	6,552	162,124	274	845	844	753	3	84	560
Western	231,235	2,314,567	3,197	16,863	16,824	15,671	34	1,263	10,041
South Dakota	14	308	1	2	2	1	0	0	1
Texas	2,867	54,830	295	538	538	491	1	28	189
Utah	73,629	1,350,815	1,896	9,172	9,142	8,388	11	738	5,857
Washington	817	20,206	34	105	105	94	0	10	70
Wyoming	23,479	388,293	1,659	3,919	3,918	3,547	6	212	1,684
Total	***824,031***	***11,532,114***	***21,757***	***101,941***	***91,183***	***77,102***	***140***	***6,249***	***48,544***

TABLE 4-2

Annual Emissions Summary for Prescribed Fire Treatment under the Preferred Alternative (Alternative B)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	825,475	10,605,525	14,350	71,050	71,050	63,280	139	5,810	46,830
Arizona	42,112	805,255	4,333	7,903	7,900	7,214	13	418	2,781
California	23,405	551,837	2,969	3,150	3,149	2,624	4	287	1,906
Colorado	20,263	387,451	2,085	3,802	3,801	3,471	6	201	1,338
Idaho	67,028	1,474,609	3,128	7,688	7,686	6,524	11	742	4,290
Montana	6,293	138,439	294	722	722	613	1	70	403
Nebraska	0	0	0	0	0	0	0	0	0
Nevada	125,865	2,407,336	12,966	23,648	23,613	21,563	39	1,251	8,310
New Mexico	66,444	1,218,998	1,711	27,494	17,858	11,413	12	667	5,283
North Dakota	0	0	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
Oregon (Total)	639,813	6,664,030	9,338	47,646	47,539	44,190	99	3,624	28,524
Eastern	17,629	436,226	737	2,274	2,271	2,025	8	226	1,506
Western	622,184	6,227,804	8,601	45,373	45,268	42,165	91	3,397	27,017
South Dakota	133	2,933	6	15	15	13	0	1	9
Texas	2,867	54,816	295	538	538	491	1	28	189
Utah	66,444	1,218,998	1,711	8,277	8,250	7,569	10	666	5,286
Washington	1,483	36,704	62	191	191	170	1	19	127
Wyoming	114,311	1,890,433	8,077	19,079	19,074	17,271	31	1,031	8,201
Total	***2,001,936***	***27,457,364***	***61,325***	***221,203***	***211,386***	***186,406***	***367***	***14,815***	***113,477***

TABLE 4-3

Annual Emissions Summary for Mechanical Treatment under the No Action Alternative (Alternative A)

State	Pollutant (tons)								
	CO	**CO_2**	**NO_X**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**SO_2**	**VOCs**
Alaska	0	41	1	1	0	0	0	0	0
Arizona	1	187	5	6	1	1	0	0	0
California	3	409	11	12	2	2	0	1	1
Colorado	9	1,380	37	9,856	4,924	1,972	0	2	3
Idaho	22	3,439	93	828	403	167	0	6	8
Montana	1	181	5	493	246	99	0	0	0
Nebraska	0	0	0	0	0	0	0	0	0
Nevada	36	5,763	155	175	29	27	0	10	13
New Mexico	2	364	10	171	83	34	0	1	1
North Dakota	0	1	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
Oregon (Total)	21	3,294	89	11,942	5,953	2,387	0	6	7
Eastern	8	1,318	36	11,121	5,555	2,224	0	2	3
Western	12	1,976	53	821	398	163	0	4	4
South Dakota	0	12	0	0	0	0	0	0	0
Texas	0	0	0	0	0	0	0	0	0
Utah	12	1,896	51	35	7	7	0	3	4
Washington	0	32	1	1,953	976	391	0	0	0
Wyoming	2	357	10	969	483	194	0	1	1
Total	***109***	***17,356***	***468***	***26,441***	***13,107***	***5,281***	***0***	***30***	***38***

TABLE 4-4

Annual Emissions Summary for Mechanical Treatment under the Preferred Alternative (Alternative B)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	1	177	5	3	1	0	0	0	0
Arizona	5	807	22	25	4	4	0	1	2
California	4	693	19	21	3	3	0	1	2
Colorado	21	3,410	92	24,351	12,165	4,871	0	6	8
Idaho	72	11,479	310	2,763	1,346	557	0	20	25
Montana	3	541	15	1,473	735	295	0	1	1
Nebraska	0	0	0	0	0	0	0	0	0
Nevada	193	30,799	831	936	155	143	0	55	68
New Mexico	6	1,010	27	475	231	95	0	2	2
North Dakota	0	1	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
Oregon (Total)	49	7,832	211	28,394	14,155	5,676	0	14	17
Eastern	20	3,133	85	26,443	13,208	5,289	0	6	7
Western	29	4,699	127	1,952	947	387	0	8	10
South Dakota	0	21	1	0	0	0	0	0	0
Texas	0	0	0	0	0	0	0	0	0
Utah	47	7,513	203	139	29	26	0	13	17
Washington	1	152	4	9,385	4,692	1,877	0	0	0
Wyoming	12	1,937	52	5,253	2,621	1,051	0	3	4
Total	***414***	***66,372***	***1,792***	***73,218***	***36,137***	***14,598***	***0***	***116***	***146***

TABLE 4-5

Annual Emissions Summary for Manual Treatment under the No Action Alternative (Alternative A)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	23.5	0.0	0.1	3.2	1.3	0.7	0.0	0.0	3.9
Arizona	2.4	0.0	0.0	0.3	0.1	0.1	0.0	0.0	0.4
California	20.4	0.0	0.1	2.6	1.0	0.6	0.0	0.0	3.4
Colorado	47.8	0.0	0.2	3.4	1.8	1.4	0.0	0.0	8.0
Idaho	43.7	0.0	0.2	3.1	1.6	1.2	0.0	0.0	7.3
Montana	22.6	0.0	0.1	1.9	0.9	0.6	0.0	0.0	3.8
Nebraska	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nevada	43.4	0.0	0.2	5.6	2.2	1.3	0.0	0.0	7.3
New Mexico	28.3	0.0	0.1	3.3	1.4	0.8	0.0	0.0	4.7
North Dakota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oklahoma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oregon (Total)	487.8	0.0	2.1	59.9	25.2	14.8	0.0	0.0	81.9
Eastern	150.5	0.0	0.7	14.0	6.5	4.4	0.0	0.0	25.2
Western	337.3	0.0	1.4	45.9	18.8	10.4	0.0	0.0	56.7
South Dakota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Texas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utah	102.4	0.0	0.5	10.9	4.7	3.0	0.0	0.0	17.2
Washington	4.9	0.0	0.0	0.3	0.2	0.1	0.0	0.0	0.8
Wyoming	2.3	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.4
Total	***829.5***	***0.0***	***3.6***	***94.7***	***40.5***	***24.7***	***0.0***	***0.0***	***139.1***

TABLE 4-6

Annual Emissions Summary for Manual Treatment under the Preferred Alternative (Alternative B)

State	Pollutant (tons)								
	CO	**CO_2**	**NO_X**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**SO_2**	**VOCs**
Alaska	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arizona	5.6	0.0	0.0	0.7	0.3	0.2	0.0	0.0	0.9
California	24.2	0.0	0.1	3.1	1.2	0.7	0.0	0.0	4.0
Colorado	129.1	0.0	0.6	9.2	4.9	3.6	0.0	0.0	21.7
Idaho	304.5	0.0	1.3	21.8	11.5	8.6	0.0	0.0	51.1
Montana	23.2	0.0	0.1	1.9	0.9	0.7	0.0	0.0	3.9
Nebraska	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nevada	276.9	0.0	1.3	35.9	14.1	8.3	0.0	0.0	46.4
New Mexico	50.2	0.0	0.2	5.8	2.4	1.5	0.0	0.0	8.4
North Dakota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oklahoma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oregon (Total)	998.9	0.0	4.3	122.6	51.7	30.3	0.0	0.0	167.8
Eastern	308.1	0.0	1.4	28.6	13.2	8.9	0.0	0.0	51.7
Western	690.7	0.0	2.9	93.9	38.4	21.4	0.0	0.0	116.1
South Dakota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Texas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utah	93.6	0.0	0.4	9.9	4.3	2.8	0.0	0.0	15.7
Washington	58.0	0.0	0.2	3.8	2.1	1.6	0.0	0.0	9.7
Wyoming	7.7	0.0	0.0	0.7	0.3	0.2	0.0	0.0	1.3
Total	***1,971.9***	***0.0***	***8.5***	***215.4***	***93.7***	***58.5***	***0.0***	***0.0***	***330.9***

TABLE 4-7

Annual Emissions Summary for Biological Treatment under the No Action Alternative (Alternative A)

State	Pollutant (tons)								
	CO	**CO_2**	**NO_X**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**SO_2**	**VOCs**
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	0.23	0.00	0.03	1.20	0.28	0.04	0.00	0.00	0.02
California	2.76	0.00	0.30	14.16	3.32	0.46	0.00	0.00	0.19
Colorado	0.13	0.00	0.01	0.38	0.09	0.01	0.00	0.00	0.01
Idaho	0.26	0.00	0.03	0.78	0.19	0.03	0.00	0.00	0.02
Montana	2.94	0.00	0.32	8.15	2.03	0.27	0.00	0.00	0.20
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	0.06	0.00	0.01	0.28	0.07	0.01	0.00	0.00	0.00
New Mexico	0.02	0.00	0.00	0.07	0.02	0.00	0.00	0.00	0.00
North Dakota	0.02	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	0.10	0.00	0.01	0.62	0.16	0.02	0.00	0.00	0.01
Eastern	0.03	0.00	0.00	0.11	0.03	0.00	0.00	0.00	0.00
Western	0.07	0.00	0.01	0.50	0.13	0.02	0.00	0.00	0.00
South Dakota	0.01	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00
Texas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utah	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Washington	0.03	0.00	0.00	0.08	0.02	0.00	0.00	0.00	0.00
Wyoming	0.04	0.00	0.00	0.12	0.03	0.00	0.00	0.00	0.00
Total	***6.60***	***0.00***	***0.71***	***25.93***	***6.24***	***0.84***	***0.00***	***0.00***	***0.45***

TABLE 4-8

Annual Emissions Summary for Biological Treatment under the Preferred Alternative (Alternative B)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	0.56	0.00	0.06	2.88	0.68	0.09	0.00	0.00	0.04
California	4.05	0.00	0.44	20.80	4.88	0.68	0.00	0.00	0.27
Colorado	0.36	0.00	0.04	1.04	0.25	0.03	0.00	0.00	0.03
Idaho	1.84	0.00	0.20	5.47	1.33	0.18	0.00	0.00	0.13
Montana	4.62	0.00	0.51	12.81	3.19	0.42	0.00	0.00	0.31
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	0.36	0.00	0.04	1.86	0.44	0.06	0.00	0.00	0.02
New Mexico	0.06	0.00	0.01	0.25	0.06	0.01	0.00	0.00	0.00
North Dakota	0.02	0.00	0.00	0.07	0.02	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	0.27	0.00	0.03	1.75	0.45	0.06	0.00	0.00	0.02
Eastern	0.09	0.00	0.01	0.32	0.08	0.01	0.00	0.00	0.01
Western	0.18	0.00	0.02	1.43	0.38	0.05	0.00	0.00	0.01
South Dakota	0.02	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00
Texas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utah	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Washington	0.03	0.00	0.00	0.08	0.02	0.00	0.00	0.00	0.00
Wyoming	0.11	0.00	0.01	0.32	0.08	0.01	0.00	0.00	0.01
Total	***12.30***	***0.00***	***1.34***	***47.37***	***11.41***	***1.54***	***0.00***	***0.00***	***0.83***

TABLE 4-9

Annual Emissions Summary for Chemical Treatment under the No Action Alternative (Alternative A)

State	Pollutant (tons)								
	CO	**CO_2**	**NO_X**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**SO_2**	**VOCs**
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	0.93	0.00	0.11	4.02	0.85	0.12	0.00	0.00	0.07
California	0.49	0.00	0.06	2.14	0.45	0.06	0.00	0.00	0.03
Colorado	0.76	0.00	0.09	1.81	0.40	0.05	0.00	0.00	0.07
Idaho	5.34	0.00	0.64	13.30	2.90	0.37	0.00	0.00	0.38
Montana	2.17	0.00	0.26	5.05	1.13	0.14	0.00	0.00	0.15
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	1.31	0.00	0.15	5.76	1.23	0.17	0.00	0.00	0.09
New Mexico	5.29	0.00	0.59	19.33	4.32	0.59	0.00	0.00	0.44
North Dakota	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	1.97	0.00	0.22	10.37	2.47	0.35	0.00	0.00	0.14
Eastern	0.81	0.00	0.10	2.55	0.56	0.07	0.00	0.00	0.06
Western	1.15	0.00	0.13	7.82	1.91	0.27	0.00	0.00	0.08
South Dakota	0.05	0.00	0.01	0.13	0.03	0.00	0.00	0.00	0.00
Texas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utah	2.57	0.00	0.30	9.05	1.98	0.27	0.00	0.00	0.22
Washington	0.18	0.00	0.02	0.42	0.09	0.01	0.00	0.00	0.01
Wyoming	2.57	0.00	0.30	6.02	1.31	0.17	0.00	0.00	0.22
Total	***23.63***	***0.00***	***2.75***	***77.40***	***17.16***	***2.30***	***0.00***	***0.00***	***1.82***

TABLE 4-10

Annual Emissions Summary for Chemical Treatment under the Preferred Alternative (Alternative B)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	3.40	0.00	0.41	14.66	3.09	0.42	0.00	0.00	0.24
California	0.55	0.00	0.06	2.37	0.50	0.07	0.00	0.00	0.04
Colorado	2.06	0.00	0.24	4.88	1.07	0.14	0.00	0.00	0.18
Idaho	24.24	0.00	2.92	60.35	13.18	1.67	0.00	0.00	1.71
Montana	4.98	0.00	0.60	11.58	2.58	0.32	0.00	0.00	0.35
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	10.81	0.00	1.26	47.63	10.18	1.39	0.00	0.00	0.75
New Mexico	4.85	0.00	0.54	17.73	3.97	0.54	0.00	0.00	0.40
North Dakota	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	4.68	0.00	0.53	28.77	6.97	0.99	0.00	0.00	0.32
Eastern	0.81	0.00	0.15	2.55	0.56	0.07	0.00	0.00	0.06
Western	3.87	0.00	0.43	26.22	6.40	0.91	0.00	0.00	0.26
South Dakota	0.08	0.00	0.01	0.20	0.05	0.01	0.00	0.00	0.01
Texas	1.07	0.00	0.13	2.46	0.55	0.07	0.00	0.00	0.08
Utah	2.43	0.00	0.28	8.56	1.88	0.25	0.00	0.00	0.21
Washington	0.43	0.00	0.05	1.01	0.23	0.03	0.00	0.00	0.03
Wyoming	2.43	0.00	0.28	5.69	1.24	0.16	0.00	0.00	0.21
Total	***62.01***	***0.00***	***7.31***	***205.89***	***45.49***	***6.06***	***0.00***	***0.00***	***4.53***

TABLE 4-11

Annual Emissions Summary for Chemical Treatment under Alternative C (No Use of Herbicides)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	0	0	0	0	0	0	0	0	0
Arizona	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0
Colorado	0	0	0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0
Montana	0	0	0	0	0	0	0	0	0
Nebraska	0	0	0	0	0	0	0	0	0
Nevada	0	0	0	0	0	0	0	0	0
New Mexico	0	0	0	0	0	0	0	0	0
North Dakota	0	0	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
Oregon (Total)	0	0	0	0	0	0	0	0	0
Eastern	0	0	0	0	0	0	0	0	0
Western	0	0	0	0	0	0	0	0	0
South Dakota	0	0	0	0	0	0	0	0	0
Texas	0	0	0	0	0	0	0	0	0
Utah	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0

TABLE 4-12

Annual Emissions Summary for Chemical Treatment under Alternative D (No Aerial Spraying)

State	Pollutant (tons)								
	CO	CO_2	NO_X	TSP	PM_{10}	$PM_{2.5}$	Pb	SO_2	VOCs
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	1.75	0.00	0.14	14.45	3.05	0.42	0.00	0.00	0.10
California	0.56	0.00	0.07	2.41	0.51	0.07	0.00	0.00	0.04
Colorado	2.49	0.00	0.24	5.74	1.21	0.15	0.00	0.00	0.18
Idaho	25.63	0.00	3.63	63.68	13.86	1.76	0.00	0.00	1.95
Montana	5.15	0.00	0.61	11.88	2.63	0.33	0.00	0.00	0.36
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	13.46	0.00	2.16	57.73	12.08	1.64	0.00	0.00	1.09
New Mexico	6.37	0.00	1.05	21.26	4.70	0.63	0.00	0.00	0.78
North Dakota	0.001	0.00	0.00	0.003	0.001	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	3.89	0.00	0.40	20.55	4.81	0.67	0.00	0.00	0.26
Eastern	1.39	0.00	0.15	4.26	0.93	0.12	0.00	0.00	0.09
Western	2.50	0.00	0.25	16.29	3.88	0.55	0.00	0.00	0.16
South Dakota	0.10	0.00	0.01	0.23	0.05	0.01	0.00	0.00	0.01
Texas	1.113	0.00	0.129	2.538	0.558	0.07	0.00	0.00	0.077
Utah	2.63	0.00	0.29	9.17	1.98	0.27	0.00	0.00	0.22
Washington	0.50	0.00	0.05	1.13	0.25	0.03	0.00	0.00	0.03
Wyoming	19.84	0.00	2.07	46.05	9.80	1.23	0.00	0.00	1.55
Total	***83.48***	***0.00***	***10.85***	***256.82***	***55.49***	***7.28***	***0.00***	***0.00***	***6.65***

TABLE 4-13

Annual Emissions Summary for Chemical Treatment under Alternative E

State	Pollutant (tons)								
	CO	**CO_2**	**NO_X**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**SO_2**	**VOCs**
Alaska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arizona	1.70	0.00	0.20	7.33	1.54	0.21	0.00	0.00	0.12
California	0.27	0.00	0.03	1.18	0.25	0.03	0.00	0.00	0.02
Colorado	1.03	0.00	0.12	2.44	0.53	0.07	0.00	0.00	0.09
Idaho	12.12	0.00	1.46	30.17	6.59	0.84	0.00	0.00	0.86
Montana	2.49	0.00	0.30	5.79	1.29	0.16	0.00	0.00	0.18
Nebraska	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nevada	5.41	0.00	0.63	23.81	5.09	0.70	0.00	0.00	0.38
New Mexico	2.43	0.00	0.27	8.86	1.98	0.27	0.00	0.00	0.20
North Dakota	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oklahoma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oregon (Total)	3.32	0.00	0.38	17.48	4.17	0.58	0.00	0.00	0.23
Eastern	1.39	0.00	0.16	4.36	0.97	0.13	0.00	0.00	0.10
Western	1.94	0.00	0.21	13.11	3.20	0.46	0.00	0.00	0.13
South Dakota	0.04	0.00	0.00	0.10	0.02	0.00	0.00	0.00	0.00
Texas	0.53	0.00	0.07	1.23	0.27	0.03	0.00	0.00	0.04
Utah	1.21	0.00	0.14	4.28	0.94	0.13	0.00	0.00	0.10
Washington	0.22	0.00	0.03	0.51	0.11	0.01	0.00	0.00	0.02
Wyoming	1.21	0.00	0.14	2.85	0.62	0.08	0.00	0.00	0.10
Total	***31.98***	***0.00***	***3.77***	***106.03***	***23.40***	***3.11***	***0.00***	***0.00***	***2.34***

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